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CHARLES F. SCOTT, PRESIDENT OF THE SOCIETY.

Charles Felton Scott, President of the Society for the Promotion of Engineering Education, was born at Athens, Ohio, in 1864. After graduating from Ohio State University in 1885, of which his father was President, he took graduate work at Johns Hopkins University while teaching in the B. & O.R.R. Technological School. In 1888 he entered the employ of the Westinghouse Electric and Manufacturing Company starting in the testing department and has been consulting engineer since 1904. He was influential in the practical development of alternating-current apparatus as is indicated by the number of patents in his name.

He is well known in connection with his work on the induction motor, the transformer and inductive interference.

While with the Westinghouse Company he was interested in the educational development of employees and founded the Westinghouse Club, the *Electric Journal* and the summer course for engineering teachers. His constructive foresight, while president of the American Institute of Electrical Engineers, led to the development of Sections and the establishment of University Branches. He was chairman of the Building Committee of the Engineering Societies Building presented by Mr. Carnegie. He accepted the professorship of electrical engineering at Yale in 1911 and has always been interested in engineering education.

He is a member of many national engineering societies, including the A. I. E. E., A. S. M. E., I. E. E., I. E. S., American Engineering Council, and the Technical Advisory Committee of the N. E. L. A.

THE COLLEGE OF ENGINEERING OF THE UNIVERSITY OF ILLINOIS.

BY H. F. MOORE,

Research Professor of Engineering Materials.

In the College of Engineering of the University of Illinois it is recognized that the first duty of the faculty is to teach, and to teach thoroughly and effectively; it is further recognized that the energy and the time of the members of the instructional staff should be given primarily to the work of the college. All this means that the faculty is not content merely to record grades and to drop students who fall below the minimum requirement, but that each year no small amount of time and energy is expended in studying the performance of the students, in judging of the effectiveness of the teaching work of the college, and in discussing methods of handling classroom and laboratory work. This tradition of the college means that there is a careful attempt (especially in the case of freshmen) to eliminate the "misfit" student before he becomes a subject for formal faculty action. This attempt is successful in the majority of cases.

Another effect of the tradition that the college has first right to the energies of every member of the faculty is the belief, which is quite generally held at Illinois, that the field in which the extra-teaching energy of the faculty man may best be expended is that of research. The college has set as its ideal not merely the teaching of current knowledge, but that ideal plus the attempt to discover new facts and new laws in the field of engineering. The agency which has been most powerful in fostering this spirit of research is the Engineering Experiment Station, which was organized in 1903. The station has no separate buildings, nor are its laboratories separate from the student laboratories of the college, and its administrative staff comprises the heads of departments of

the college. There is a group of some dozen or fifteen special investigators who give their entire time to the work of the station, and the members of the instructional staff are encouraged to undertake research problems in addition to their teaching work, and to use the bulletins of the station for the publication of the results of that research work.

General View of the College of Engineering, University of Illinois.

This research atmosphere has a marked favorable effect on the work of the class room. The typical Illinois instructor is not content merely to teach facts, nor does he accept blindly the statements in the standard textbooks; he has a well-developed appetite for investigation, and is always striving to replace the empirical with the rational. The Illinois

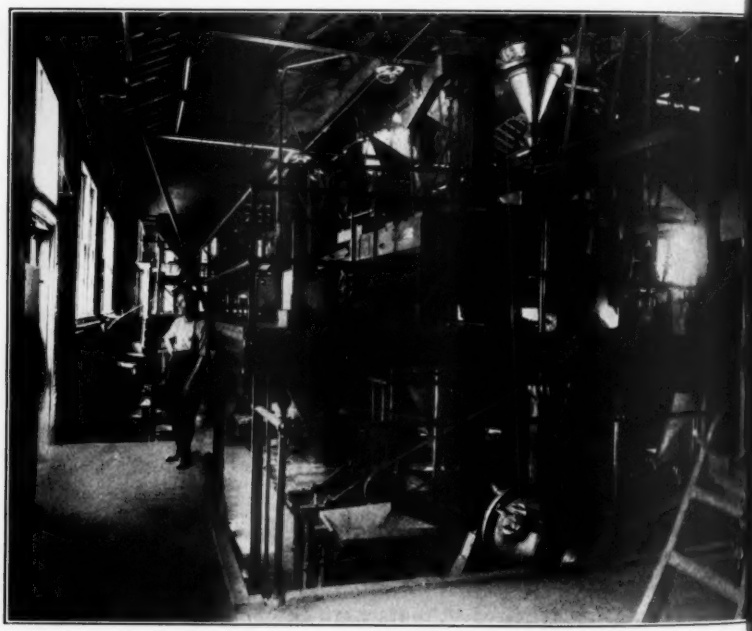
student is encouraged to ask the *why* of things and to examine critically the statements of his texts—and of his instructors.

One unusual feature of the organization of the College of Engineering is that it includes the university department of physics. This has made possible an unusually good degree of coöperation between physics and the more technical engineering subjects, and has notably diminished the "sophomore slump" in physics. The laboratories of the department of physics are housed in a large building in the engineering group. To the visitor to the physics laboratories points of special interest are: the system of placing lecture apparatus in stacks, similar to library stacks; the arrangement of the building with one wing given up to large laboratories for class work, and another wing with small rooms for research work; and the finely equipped shop of the department in which many pieces of delicate apparatus have been made.

The shop laboratories of the College of Engineering have a well-defined and distinctive objective. The aim of the courses in shop is not to train the student to become a skilled mechanic nor to develop any high degree of manual dexterity, but to give him a view of the function and organization of a manufacturing establishment. Passing through courses in pattern shop, foundry, forge shop, and machine shop the student becomes familiar with the major divisions of production of manufactured objects. The shops have a regular output, a small gasoline engine, and the equipment includes jigs and fixtures for manufacturing the engine, a testing floor, and an inspection department, giving, in outline, a complete manufacturing plant. In the latter part of his shop course the student is required to route work through the shops and to plan manufacturing operations. Throughout the course time-study methods are used, and the student is taught to think of the shop in terms of economic production as well as in terms of the technique of machine practice.

In the College of Engineering there is a flourishing de-

partment of ceramics and ceramic engineering. This department was founded in response to the desire of the clay-working interests of the state for a center of technical education and research to minister to their needs. The problems of clay-working, including both the making of pottery and the making of brick, together with the technology of glass making are studied. There is a well-equipped kiln room, as well as chemical and physical laboratories for the study and testing of raw materials and product.



Mining Laboratory, University of Illinois.

Illinois is a coal-mining state, and the department of mining engineering finds its major problems in connection with the mining of bituminous coal. The laboratories of the de-

partment are equipped with apparatus for the washing and sorting of coal, and there are special laboratories for the study of safety lamps, mine gases, and explosives. The headquarters of the State geological survey are located in one of the buildings of the Engineering group, as are offices of the U. S. Bureau of Mines.

The equipment of the department of Railway Engineering includes the largest locomotive testing laboratory in the United States, and this laboratory is so arranged that it can be enlarged to take in even heavier locomotives than can at present be handled. The equipment also includes test cars, both for steam railway service and for electric railway service. The tracks of the Illinois Traction System pass the door of the locomotive testing laboratory, and furnish connection with the steam lines leading into the cities of Champaign and Urbana, so that it is possible to bring railway equipment directly to the locomotive testing laboratory.

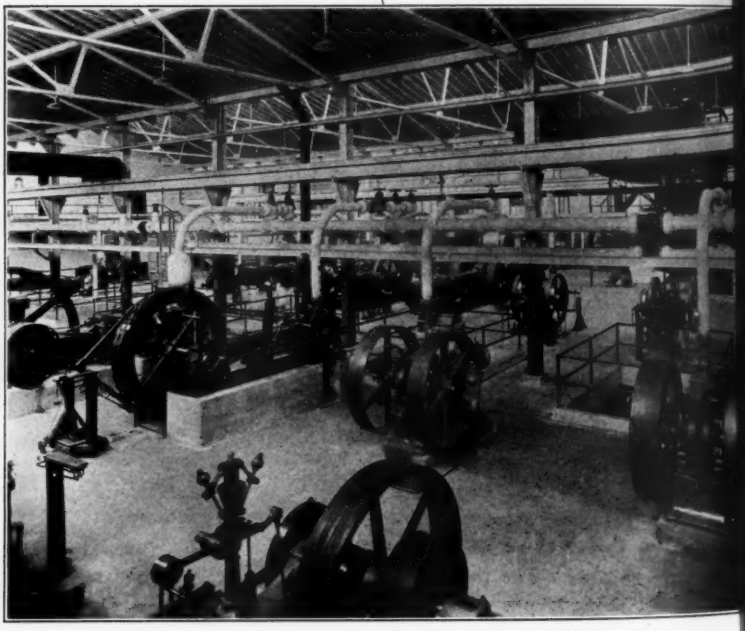
The building which houses the offices of the departments of railway engineering and of mining engineering also houses the department of general engineering drawing. There is no more important teaching department than this one. It forms a point of contact of the College of Engineering with the freshman student. In the freshman drafting room the student is introduced to the elementary problems of planning and design, and the course serves as a motivation course to the freshman engineering student.

The power laboratories of the department of mechanical engineering are housed in a structure containing three long bays, one of which is given up mainly to steam engines and auxiliary apparatus, a second of which contains internal combustion engines, air compressors, and refrigerating machinery, while the third bay is devoted to heating and ventilating apparatus. The engines are placed on a heavy flat slab concrete floor, with condensers, weighing scales, and weir channels underneath this floor. Crane service is provided for two of the bays. The bay devoted to heating and venti-

lation contains equipment for testing of warm air furnaces.

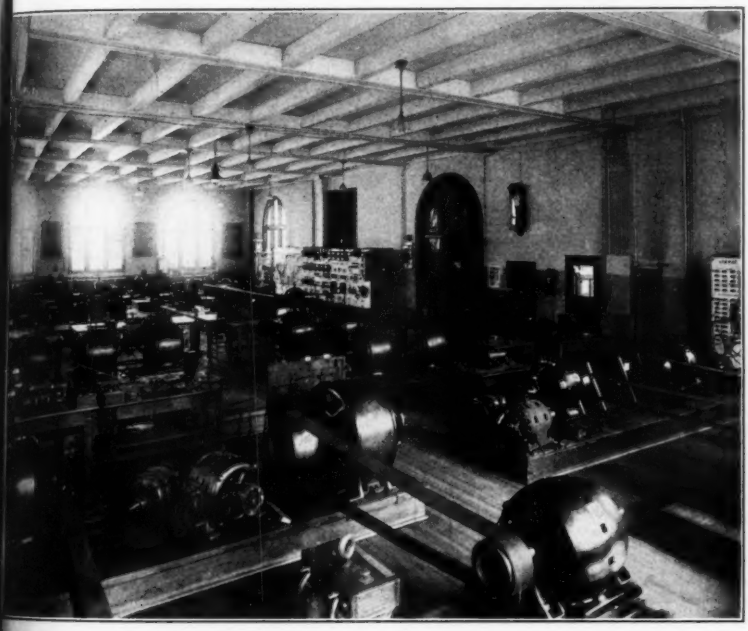
The laboratories of the department of civil engineering are housed in the same building with the mechanical engineering laboratories. They include a cement laboratory and a road materials laboratory. An experimental road slab is located near the college buildings. This slab is fitted with apparatus for measuring the change of soil pressure and the change of deflection at various points due to change of temperature and of weather conditions.

A high-tension laboratory, a calibration laboratory, and a general dynamo laboratory are all housed in the electrical engineering building. The dynamo laboratory occupies the



Power Laboratory, Department of Mechanical Engineering, University of Illinois.

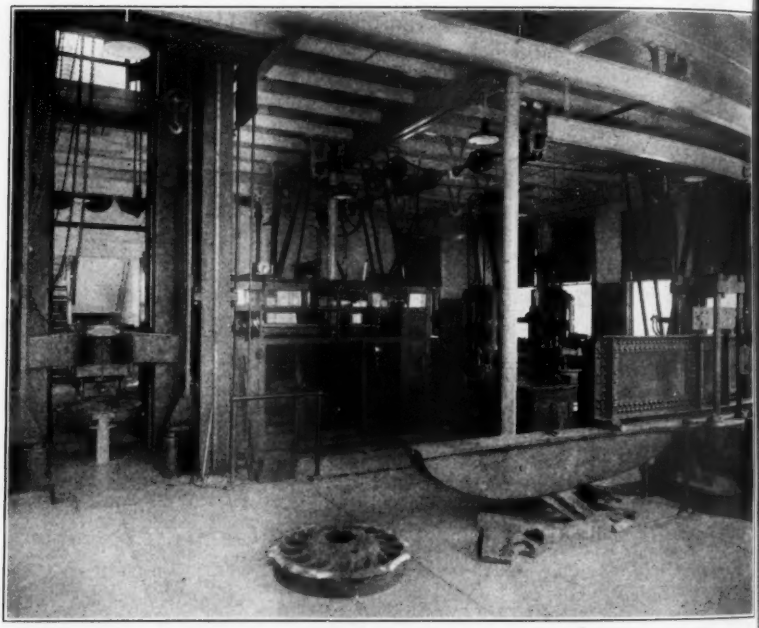
main floor of the building, and is remarkably well equipped for handling large groups of students. Load for the various types of generating apparatus used is furnished by large banks of lamps placed on the walls of the laboratory room. Throughout the laboratory very careful attention has been given to the choosing of dynamos and motors so adapted to each other that the whole equipment has a high degree of flexibility and interchangeability.



Dynamo Laboratory, Department of Electrical Engineering, University of Illinois.

The materials testing laboratories and the hydraulic laboratory are both under the administrative direction of the department of theoretical and applied mechanics. The ma-

terials testing laboratories are housed in three separate buildings, the main laboratory containing a large equipment of standard testing machines, including a 600,000-pound machine which will take specimens 30 feet long. The concrete laboratory is housed in the Ceramics building and contains



Materials Testing Laboratory, University of Illinois.

moist-storage rooms, stock rooms, a small cement laboratory, mixing machinery, and a 300,000-pound testing machine which will take beams of 20-feet span. The laboratory for the investigation of the fatigue of metals is in the old boiler house of the university and contains what is, perhaps, the most extensive equipment in this country for the study of the effect of repeated stress.

The hydraulic laboratory is located in the same building with the main materials testing laboratory. The hydraulic problems encountered in Illinois towns and cities are more commonly problems of water supply than they are problems of water power and the equipment of the hydraulic laboratory is specially adapted for instruction and research in the problems of pumping, measuring, and filtering water, and of the flow of water through pipes and orifices. The pumping equipment of the laboratory is capable of maintaining a flow of 7000 gallons per minute.

At the University of Illinois the work in metallurgy is carried on as a part of the work of the department of chemistry, which is not a part of the College of Engineering. The equipment in metallurgy and metallography is excellent, and the College of Engineering is kept in touch with this work through the professor of appled chemistry who is a member of the executive staff of the Engineering Experiment Station.

At Illinois the course in chemical engineering is administered by the department of chemistry, which is a department of the College of Literature, Arts and Sciences. The liason between the chemical engineers and the College of Engineering is, however, close, and the chemical engineers take their physics, mechanics, and thermodynamics in the College of Engineering. The department of chemistry occupies a large four-story building just a little south of the group of engineering buildings.

The drafting rooms, offices, and class rooms of the department of architecture occupy the upper two floors of the main Engineering building. This department offers two courses, one in architecture and one in architectural engineering. To the visitor to this department the Ricker library of architecture is usually of especial interest. This library contains a remarkably fine collection of books, and is fitted not merely with chairs and reading tables, but also with drawing tables so that sketches from books can be made in the library.

The general library of the College of Engineering is in the

basement of the main Engineering building. This library and the "library habit" for engineering students has been developed by the joint efforts of the faculty of the College of Engineering and the faculty of the University Library School. The librarians of the engineering library have been members of the staff of the general library of the university, and they have been markedly successful in developing among the engineering students the ability to use a library and the habit of doing so.

At Illinois there are in progress a number of coöperative investigations, carried on jointly by the Engineering Experment Station and various outside interests. It is believed that such joint investigations furnish an effective contact with actual problems in engineering, that the stimulating effect of such investigations on the instructional staff and the student body is excellent, and that through such investigations an engineering college can make effective contributions to the advancement of the science of engineering. The following joint investigations are now in progress at Illinois, and the apparatus and methods used are among the points of interest to visitors.

1. Investigations of coal mining in Illinois, conducted in the laboratories of the department of mining engineering, in coöperation with the U. S. Bureau of Mines and the Illinois State Geological Survey.
2. Investigations of the manufacture of gas from Illinois coal, conducted in the laboratories of the department of applied chemistry, in coöperation with the Illinois Gas Association.
3. Investigation of the coking of coal, conducted in the laboratories of the department of applied chemistry, in coöperation with A. T. Hert of Louisville, Kentucky.
4. Investigation of the stresses in railway track, conducted in the laboratories of the Department of Theoretical and Applied Mechanics, in coöperation with the American

Society of Civil Engineers and the American Railway Engineering Association.

5. Investigation of warm-air furnaces and furnace heating, conducted in the laboratories of the Department of Mechanical Engineering, in coöperation with the National Warm-air Heating and Ventilating Association.
6. Investigation of the fatigue of metals, conducted in the laboratories of the department of theoretical and applied mechanics, in coöperation with the National Research Council, Engineering Foundation, and the General Electric Company.
7. Investigation of the viscosity and electrical conductivity of glass, conducted in the laboratories of the Department of Ceramic Engineering, in coöperation with the National Research Council, through the Corning Glass Works fellowship.
8. Investigation of sewage disposal by the department of municipal and sanitary engineering at a special sewage disposal plant near the city of Urbana, in coöperation with the Agricultural Experiment Station and the Illinois Water Survey.
9. Investigation of oiled roads, conducted by the department of civil engineering, in coöperation with various oil-producing firms, various firms manufacturing road machinery, and Champaign County, Illinois.

AIMS AND MEANS IN COLLEGE EDUCATION.

BY VLADIMIR KARAPETOFF,

Professor of Electrical Engineering at Cornell University.

Comparatively few have the privilege of a college education, and for this reason a college-bred individual ought to be a leader of his times, in thought, in action, in lofty emotions, and in bodily strength. Consequently, the fundamental aims in college education must be (*a*) to prepare the soil for such a leadership, (*b*) to plant proper seeds, and (*c*) to watch them germinate. Such a definition is broad enough to be applicable to backward and imperialistic countries, to conservative England, to liberal America and to communistic Russia. It probably would also fit the best educational aims of ancient Greece and Rome. The only difference lies in the ideals of leadership, which ideals depend upon the times and upon each individual's natural abilities and inclinations.

The greatest problem of our times is that of economic justice, and it is casting its shadow or giving its tinge to almost any other problem of our times. A college which does not plant in its students the proper seeds for an intelligent understanding of the economic forces at play and a sympathetic desire for a permanent amelioration of the masses, falls short of its most sacred duty. I do not mean any partisan theory, nor do I mean the childish alchemy now taught under the name of "Economics of Business." A medical student is shown diseases and sufferings in all their nakedness. Why not the student of economics?

Another all-important problem for the next generation is that of collective consciousness, that is, the promotion of the necessary and beneficial change from individualism to collectivism. I do not mean this in the narrow economic or political sense only, but welcome this growth of the "group person" in all phases of human activity, including sciences

and arts. We have only glimpses of the possibilities in this direction, but you ask a member of the staff of a large research laboratory or of a first-class orchestra, and they can tell you of the new thrill of several strong minds working in harmony. And one of the products of this collective consciousness is going to be a higher and more refined sense of duty and joy of goodness, known as "group morality." What a worthy educational aim to teach this collectivism to students in their daily life, a collectivism of strong free beings.

But, you would say, the attainment of personal happiness has always been put forward as the strongest motive for action, and how can you change human nature and substitute for it the ideal of service to the community or to humanity? Well, there was a time when human society encouraged those individuals who were physically strong and brutal; there was a time (and it is still with us) when we put the cunning and the selfish on the pedestal. But the changing order of things pushes forward the individual who finds his pleasure and the highest attainment of "personal happiness" in service. We are learning to encourage individuals who like to minister, and we are putting all kinds of dampers on those who like to be ministered unto. The noted German chemist and philosopher, Wilhelm Ostwald, holds the most important requisite for happiness to be the greatest amount of completely transformable free energy. To me this means about the same as "find your happiness in your work or you will not know what happiness is." His second requisite lays emphasis upon this energy being transformed voluntarily, and this again calls for that socially desirable type of individual for whom service is a privilege and a pleasure, and who seeks it as such.

Whatever broad educational aims the faculty and the trustees of a college believe in, it imposes upon them the duty of so planning the instruction and the student life, and encouraging such traditions as will make high-grade leaders and public servants out of their students twenty years hence.

It means that each mature teacher should ask himself about the possible trend of development in his speciality for many years to come, and he should teach in accordance with these steady tendencies, rather than following whimsical needs or fashions of the minute, or being beguiled by the industries into training "practical subordinates for routine duties." Each head of a department must ask himself about the possible future of the various branches in his field, and balance the instruction accordingly. The president and the trustees have to do such balancing and adjustment constantly, steering among conflicting views and demands, encouraging some tendencies, opposing others, though none too harshly so as not to be like the builders who rejected a good corner-stone.

Teaching is an art, and good teachers are born, not made. Nevertheless a naturally good teacher can be improved by proper training, as can a musician or a painter. At the present time practically nothing is being done to train young college teachers systematically, and so it comes that a cub instructor, without any understanding whatever of human nature or of the fundamental laws of applied psychology, presides over a class and majestically dispenses information and justice. He is like a wireless station tuned sharply to one particular wave length; only a few who happen to be tuned to the same frequency can understand his signals. Oh, fellow-teachers, let us become like those all-too-human wireless amateur stations that emit waves of different pitch, so that each student can get at least a faint message. Some day the message may become clear to him and guide him, or at least will give him comfort and hope.

Even the prophet of old was at times in despair how to make his people see, hear and understand his message. And who of us teachers has not asked himself thousands of times how to make the students appreciate the importance of persistent intelligent effort? But let the teacher ask himself frankly when and why he himself has made a persistent and intelligent effort in a certain direction, and what have been the mainsprings of his action. Are the conditions such that

the students can be impelled by one of such mainsprings? Is a religious motive present in them, a desire for perfection, as for immediate personal advancement, a fear of punishment, ambition for public recognition of superiority, an intense interest in the subject, a sense of higher duty, a farsighted vision for future needs, or any such known strong motive for action? Is each of his students like a pioneer gold-digger who tries to get as much as possible, or is he like a slave watching the sun and the overseer's whip? A teacher in his class is like a public performer on the stage. Both have to reach their audiences, both have to awaken in them a proper attitude, and it takes nearly a life-time for some of us to learn how to do it.

One of the comparatively new means of arousing the students' interest is a class organization, wherein each member has definite duties to perform, has certain responsibilities, and is subjected to constant approval or disapproval of the other students. We are beyond the stage at which the school has been looked upon as a preparation for life. School must be life itself, even though much intensified as compared with the gray everyday existence after graduation. A class that lacks an organization in its studies is something unnatural, abnormal, because a group of human beings always tends towards some kind of organization. Give each one a function, no matter how humble, place each one where his best ability lies in service to others, and you will have awakened him as a social being. This is much more important than the intricacies of your dinky subject.

Many teachers think that the problem of crowding the curriculum is a difficult one to solve, because the student ought to know this or that, or because a competing college has it in its catalog. A well known professor used to begin his course with the words: "Gentlemen, this is a gymnasium and not a restaurant." To me this is the most apt reply to those who advocate the prevalent crowding of curricula. Every item of our knowledge is, or will be, contained in books and magazines. If the student has learned how to

use available sources, it matters little how much has been perfunctorily covered in a course. And if he has not learned how to use books, then it also matters little whether his mental indigestion is due to ten or fourteen chapters out of your textbook.

The student or his parents must not think that it is the duty of the college to surround him with the proper conditions for study, and that he himself simply has to follow the instructions and the rules. Nothing worth while comes to us in this life without a persistent and intelligent effort on our own part. Each student, or still better a group of students, must intelligently place themselves under the proper conditions and vigilantly see to it that these conditions are preserved. Let them fight for recognition, let them fight for knowledge, let them fight for recreation, for the right of self-expression, for a life that is full and fruitful, and such a life will come to them, and the impetus gained will develop a habit of leadership which will remain with them till they are laid at rest.

SPECIFICATIONS FOR A TEACHER OF ENGINEERING.

BY FRANK H. NEFF,

Professor of Civil Engineering, Case School of Applied Science.

With your permission I will preface what I have to say by quoting from some recent notes on contracts and specifications.

"1. *General clauses or general specifications* which would apply to any construction of the same general character.

"In the case of the specifications for a contract of an engineering character, those clauses pertaining to the work to be done are of two classes.

"2. *Special clauses* which may either describe features peculiar to the particular work under consideration, or which may give the requirements that the completed structure or design shall fulfill."

In writing the specifications for a machine or process, the product must at all times be kept in mind; and while I do not wish to be considered as implying that the teacher of engineering is a machine, still it would seem that in the case of the subject for discussion, we must first write the specifications for the product, before we can intelligently write the specifications for that factor which is to influence largely, if not determine, its character.

And for both the product and this factor, for the engineering graduate as well as the teacher of engineering, it seems to me that the specifications may be broadly grouped as above in the case of a construction contract, though as in that case the line of division cannot in all cases be sharply drawn.

What do the general specifications call for in the way of qualities, that are recognized as desirable in any man of to-

day, whether he be a graduate from a school of engineering, from a school of arts, or from the school of life only?

He should have a kindly and charitable attitude toward his fellow men and should have a belief in mankind. These qualities he should have, if not for his own enjoyment of life, at least for their bearing on the problem of the relation of man to man which is the most important question now confronting those in all walks of life, and in which the engineer, on account of his peculiar position between employer and labor, is destined to play an important rôle.

He should have a becoming modesty, yet with opinions, and not afraid to express them; an energy that will cause him to take up any task however difficult, with a patience and perseverance to see it through however distant the goal; and finally an honesty of purpose that controls his every act.

What are some of the special qualities desired in the graduate in engineering?

He should have a trained mind, a mind which, as has been aptly said, "is a workshop and not a warehouse"; a mind trained to analyze in a logical way the problems that are presented.

A habit of thoroughness and accuracy of work, that will insure in the solution of engineering problems that he has taken everything into account, and that the work is correctly done.

While having that genius that has been defined as "the infinite capacity for details" he should be able to take a broad view of any problem, with judgment to correctly appraise the relative importance of its different parts and to make the solution in a broad and unbiased way.

It is not to be expected that the graduate in engineering will have acquired all of these qualities by the time he steps forward to receive his diploma, but that his training has been such that he will develop along these lines, as he proceeds with the practice of his profession.

How shall the teacher accomplish the result?

First, by example; There is no better way to impress upon the student any one of these qualities, than by practicing it. How better can one inculate a kindly and charitable attitude than by a like treatment?

The influence of the character of the head of many a plant is transmitted all down the line, and may frequently be judged by the way in which the foreman, least in authority, treats the man under him. So the teacher must be kindly and charitable.

He must be alert to the difficulties that the students under him encounter in their work. He must be quick to present the same idea in a different way, to give if possible a different point of view—yet not so quick in changing his viewpoint that the student does not follow him. He must have imagination to see in the slow student the promise of future achievement, as the engineer sees his finished structure in the raw materials.

He must have patience to work out his problem as does the engineer whose structure slowly takes form and emerges from the chaos of materials of construction.

In putting across the more special qualifications of the engineer, the teacher should treat questions broadly—this does not mean superficially—but so as to bring out the principles involved in the problem. This will train the student to do likewise.

He should be systematic in his work and carry all work to a definite conclusion, rigidly requiring similar performance on the part of the student.

He should have had sufficient experience to be able to impress on the student that he is not speaking wholly from an academic standpoint, yet he should not have been in practice so long that he looks upon the solution of a given problem as the result desired—instead of a means to an end.

He must have enthusiasm and love for his profession that will enable him to inspire in the student a like love for his work so that he will finally feel a pleasure in accomplishment, a satisfaction in work well done which will compensate him,

even though his work be of such a character that he will never have the joy of public recognition.

It is not presumed that the foregoing brief statement of qualifications has fully covered the ground, but it is hoped that it is sufficient to make a starting point for discussion.

In closing, let me quote Dr. Eliot, who said, "We must teach how to live, not how to earn a living." If we look well to the first, the second will take care of itself.

INSTRUCTION OF STUDENTS IN THE USE OF TECHNICAL LITERATURE; AN UNEXPLOITED PHASE OF ENGINEERING EDUCATION.

BY E. H. McCLELLAND,

Technology Librarian, Carnegie Library of Pittsburgh.

Though the real value of technical literature has never received adequate recognition, there is evidence of an increasing interest in the subject. In a recent letter to the editor of *Science*, it is stated that "in these days of closed bars and crowded hotels the one place where the stranger is sure of a welcome is the public library," and, continuing more seriously, the same writer says that "The dependence of the present-day investigator upon institutional libraries is almost absolute."

Never in the history of America has there been a time when scientific investigation was pursued so zealously as to-day. Almost every large manufacturing company is depending to some extent on a Research Department or Department of Technical Control, or whatever it may be called. We hear and read everywhere of research problems and research methods and there is much tardy evidence that research in America is beginning to receive the attention it so richly merits; but any intelligently directed research takes into account *first of all* the available information on the subject, and no original research can be judiciously conducted until cognizance is taken of the state of the art as recorded in the existing literature. This is pretty generally recognized, even if not universally practised. But research is only one of the purposes for which contact with technical literature is essential, and modern industrial progress is so rapid that the en-

gineer who fails to keep in touch with the current literature in his field is in danger of falling behind the procession.

It may be assumed, however, that with this audience I need not undertake to establish the merits of engineering literature or the importance of using it. These points I think are conceded and we are concerned chiefly with the problem of getting the student—the future engineer—to realize the importance and the potential value of the printed resources at his command to-day.

In the utilization of technical literature (as in many other things within the student's experience) there is no royal road to proficiency. The way to acquire proficiency in reading a foreign language is to read copiously, and the way to become an expert swimmer, or a crack marksman is to practice faithfully. Swimming and shooting usually require no artificial incentive to practice, but in promoting the study of engineering literature we find an obstacle in the rather anomalous condition that the average student is not easily interested until he has acquired some proficiency; while, on the other hand, he cannot possibly attain proficiency without considerable practice. This means that if the student is to be properly trained in the use of technical literature, the burden of responsibility for this training must be placed on some one else, and the task is not an easy one. It demands one of two things: (1) eternal vigilance in holding the student to an undertaking which he is inclined to consider rather irksome, or (2) considerable ingenuity in developing interesting and attractive features so that the subject may appeal more strongly than it does to the average student to-day.

Perhaps one reason for the average student's apathetic attitude towards engineering literature, and his failure to grasp its importance, may be found in the fact that usually the work is not dignified by any definite place in the curriculum. When time is given for this work it is frequently in substitution for a class-room or laboratory period—apparently as an afterthought. Until the study of engineering literature

is recognized to the extent of being installed in the regular curriculum, so that the student may understand it to be part of his required course and think of it in these terms, there is a sound psychological reason for his regarding it lightly.

Apropos of the apparent dearth of the highest type of scholarly research worker, something has been written to the general effect that many of our technical students are of the active, energetic type, eager for results and attracted by large and spectacular undertakings—students with no intention of plodding and with little patience for great detail, so that they do not readily settle into the restraints of research work. You who are engaged in technical education will, of course, know to what extent this opinion is correct; but I submit the thought that this impetuous type of student will be quite prone to think of work with engineering literature as a mere delving in musty books, and to be characterized as effeminate and enervating. I think his views might be modified if he could visualize technical literature as a live and growing thing, and if he could have some conception of the number of, and the eminence of, some of the successful engineers who to-day are achieving a large measure of their success through alert and intelligent use of patents, engineering reports, and technical and trade journals. I think he would view the matter from a slightly different angle if he could look through the correspondence file of a large technical library and realize the type of engineer who is demanding help from the available literature. It would help him if he were to ponder a little on the fact that the engineering literature which he may be inclined to despise is the work of notable engineers, just as much as is the bridge or the tunnel which he admires. Pittsburgh is noted for its engineers, and some of our very good books are by Pittsburghers—technical men whom the student in Pittsburgh knows by reputation, at least. Probably not only the student but the average professional engineer in Pittsburgh would be surprised to know to what extent tech-

nical literature has been enriched by our local engineers and technical men.

Another probable reason for the indifference of the student is ignorance of method; that is, he may have no knowledge at all of how to use library catalogues and indexes, or of how to use books properly when they are set before him. In his early attempts to use a library, therefore, he will probably fail to find exactly what he wants; but he should not become discouraged and blame the library. No one should expect to turn out perfect work the first time he tries to use drawing instruments or wood-working tools, especially if he be given no instruction regarding the purposes of the various tools, and the best methods of manipulation; but books and indexes are tools, also, and proficiency in their use does not come by intuition. The departments of chemistry in a number of colleges and universities have given considerable attention to courses in the use of chemical literature; but parallel courses in the use of engineering literature are even more urgently needed, since the literature of chemistry (by reason of its multiplicity of compendious reference works, its various abstracts of comprehensive scope, and its incomparably greater wealth of bibliography in general) is much more readily accessible to the worker than is the literature of engineering.

One way in which students are frequently brought in touch with scientific and technical literature is for the instructor or the librarian to select lists of books on various topics, place these on designated shelves or tables and reserve them for student use during limited periods. This has been done on a rather large scale here in Pittsburgh for 15 years or more; but this is the mere beginning—the very first step, and not a highly important one—in any scheme for imparting to the student any real and lasting knowledge of technical literature. This scheme is admirable for the student's convenience in obtaining information on some one particular subject; but practically valueless for enabling him to obtain information on any other subject. When the volumes are removed at the end of a

two-weeks' period, for example, it is extremely doubtful if the average student could re-assemble the references by looking up the material for himself. This must not be construed as condemnation of this practice. The procedure is a good one for the purpose which it is primarily designed to serve. It puts the student in touch with a certain amount of selected literature, but it generally fails to aid him in further selection.

The remedy, of course, is to give the student practice in finding his own references, and this means that he must acquire some facility in the use of indexes, catalogues, and bibliographies. Knowledge is of two kinds—that which we have and that which we can find; the latter is almost as usable and its quantity is infinitely greater.

In training students in the effective use of technical literature, responsibility rests mainly with the faculty, and one of the desiderata is that instructors shall have a fair knowledge of library methods and a thorough realization of the importance of citing references with such fullness and accuracy that there may be no difficulty in identifying them. A frequent but disheartening experience in libraries is that of trying to help the inquirer who brings in some such reference as "Government Bulletin 25"—a reference, which, of course, is impossible of identification without a knowledge of the bureau or department which issued it. The avoidance of such ambiguity is highly important when initiating a student into the technique of library methods.

In some colleges, very good work is done in seminars or assemblies of some sort in which the instructor and the students devote an occasional session to the consideration of technical literature. This has been done most frequently with classes in pure science, but there is a growing tendency to extend the practice to engineering classes. In one western university which for a number of years has featured weekly sessions in a course of this kind, it is said that graduating classes have been unanimously of the opinion that, for

the time spent on it, this course exceeds in value anything else in the curriculum. This gives evidence of a most successful course, and doubtless excellent results would be found elsewhere if we were to make a survey of the work done in various institutions.

I have very superficial knowledge of the seminar methods employed in different colleges but, apparently, attention is given chiefly to new books and to selected lists of current magazines—presumably those selected by instructors. This work is highly commendable, but there seems to be little evidence that it is supplemented by instruction which will enable the student, when thrown on his own resources, (1) to keep informed regarding new books; (2) to pick out those which are of greatest value; (3) to recognize and interpret reference books so as to approach them with some degree of assurance; (4) to select the best magazines in special fields; (5) to survey periodical literature speedily by means of indexes, abstracts, etc.; (6) to make proper use of the constantly increasing mass of official literature, issued by federal and state government agencies—in short, to keep effectively in touch with what a former professor in one of our engineering schools has aptly characterized as "printed engineering resources."*

The young engineer should not only be trained in evaluation of the books to which he has access; he should be instructed as to the sources of information regarding books not available for examination. I know a young mining engineer who ordered, merely from the publisher's announcement, a large and expensive set of volumes which he expected to be of special service to him. On arrival of the books, however, he found that, though concerned with minerals, they were of no direct value to him as they were written wholly from the viewpoint of the chemist. This rather costly experiment in book selection might have been avoided had he consulted the numerous reviews available.

* J. Martin Telleen, in BULLETIN OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, Nov., 1914, pp. 18–27.

Dependable book reviews constitute the best single source of information regarding the character of new books, and engineers might profitably devote more attention to the reviews in journals covering various branches of engineering. Libraries which are concerned with careful book selection depend to a considerable extent on book reviews, and the Carnegie Library of Pittsburgh has probably gone further than any other library in using and recording these reviews. For many years abstracts of reviews have been filed in a card-index and since 1917 a record of the reviews in numerous scientific and technical journals has been published quarterly under the title "Technical Book Review Index." This Index, which is the only publication in the world devoted to recording reviews of scientific and technical books, includes from 4,000 to 5,000 references annually, and is the most comprehensive existing guide to the evaluation of new technical books.

Modern progress is so rapid, however, that in certain fields books are in some degree obsolete when published; thus the engineer who would keep thoroughly up to date must depend largely on current periodicals and serials. These are now so numerous that the busy engineer can not afford the time necessary for examining any large part of them at first hand, so he must have recourse to indexes and abstracts. Familiarity with these is probably best acquired through insistence on bibliographic work.

The making of bibliographies is one of the most helpful forms of training; provided that the training be judiciously given. With good library facilities any college student *should* be able to make a brief and intellegible list of references on any important engineering topic, but it scarcely serves the purpose if he merely copies titles from some index. He should be taught to verify the references, amplify the titles when necessary, and evaluate the articles where possible—in short, to enable the user of his bibliography to determine definitely the scope and nature of each article

and whether it will justify the time spent in examination. Reams might be written on bibliographic method, but the last sentence above constitutes the basis of good work.

Going a step beyond bibliography we have abstracting, and students should be taught to abstract, digest, or summarize technical papers. Hundreds of scientists through the United States are regularly examining current literature and preparing digests for various abstract journals. Bibliographies and indexes are the keys to the rich storehouse of technical literature, but abstract journals are the *master-keys.* Many of the important scientific and technical societies now require every author to submit a satisfactory abstract of his paper, and it is desirable that every engineering student should have some training in this kind of work.

After the student has some conception of the nature of indexes, abstracts, bibliographies, etc., and some operating knowledge of these useful tools, one of the most potent factors in stimulating the study of technical literature, will be a class discussion (quiz, or round table, or whatever it may be called). In this discussion the instructor should verify the students' researches. This need not be a laborious matter. For example, either the instructor or the librarian may refer a student to indexes where he will find references on irrigation, but it remains for the instructor to determine how intelligently these indexes have been used. When the student reports his references, ask where he got them. Probably he will not know. Next time he will probably know that he got them from the "Engineering Index," for example, but he may not know anything *about* the index or its scope and functions—that it appears monthly, cumulates annually and is a valuable adjunct to the private engineering library.

The student should really be receiving a course in the manipulation of literary tools. It is what may be called an "operating" course, and his output should be judged not alone by the standard of quantity, but should be inspected for

quality. For example, if he submits twenty references on a particular subject, it must be determined whether they are accurate and whether they are especially applicable; that is, would they give a practising engineer helpful information on the subject under consideration. The mass of engineering literature is so enormous that the mere finding of references does not suffice; they must be the *best* references.

A little insistence on care and observation will go far to enhance the value of the work, and students may soon be brought to see that books may be identified by their authors, titles, publishers, dates, and editions; and magazine articles by the titles, dates, volumes, and pages of the magazines; and that this identification may be just as definite and accurate as the botanist's classification of plants. For the student to state that he found his information in a "little, thin, green book" is as ridiculous and unscientific as for an engineer to specify "metal rods about as thick as a man's thumb."

Students will go to the literature if there is sufficient incentive. There is one power-plant in the Pittsburgh district which engineering students are frequently required to visit and describe. An excellent description appears in one of our technical journals, and one copy of this has been cut out and a second one worn to shreds. Fortunately we have been able to secure extra copies and we now try to avoid giving out our bound volumes for this particular problem. The case is mentioned here to show that a student will use the literature if convinced that it will really help him in his required work.

One incentive to study would be to let the student see that this study may be made a revenue producer. It can hardly compete with the war-time possibility of spending a half holiday in some industrial plant and getting $5 or $6 for it; but the careful student who will acquire the principles of bibliographic work and abstracting should be able to market

the product of his spare-time work. It should be possible, for example, to sell to-day a well-digested summary of the literature on heating-furnace design, or cold-working of steel, or electric insulation. In a large industrial region there are likely to be many technical investigations under way, and the close contact between instructors and industries to-day should enable the instructor to give the exceptionally qualified student some suggestion as to problems on which bibliographies might be welcomed.

With many students the appeal will be stronger if the assigned problems have a commercial or industrial trend. Set a student to determine what companies manufacture lathes, or locomotives; in what part of the country are the plants?; what are some of the largest companies and what is their organization? Who is the president or the purchasing agent of each? What journals would offer the most fertile field for advertising their product?, and what kind of trade literature (catalogues, house-organs, etc.,) do they issue? Not all this information can be found readily—that regarding smaller companies is particularly elusive—but the search for information of this nature will properly call into use a set of tools and aids entirely different from those used in obtaining information on engineering or purely scientific topics. This sort of problem in some form comes to libraries almost daily. Very recently a young engineer, whom I had previously known only by mail, spent several hours in the Carnegie Library of Pittsburgh, his purpose being to get information on a large western company which had offered him a position.

A good practical problem would be to have a student imagine himself ordered to a foreign country (remote from libraries and book-stores) under instructions to assemble and take with him a good working library for a chemical laboratory or a civil engineer's office, for example. During the present year we have helped two men in just this emergency, and with little time to act. Books and magazines are com-

ing to be considered among the regular "tools" of an engineering or industrial works, and the engineer of to-morrow who has some knowledge of how to discover and evaluate technical literature is very likely to find that this knowledge constitutes a valuable asset.

With a general class in engineering, it would seem that an interesting session might be held occasionally with nothing but a copy of an engineering or technical index. By merely going over the titles with the students, it is inconceivable that some interest should not be aroused. If desired, an interesting general drill might be developed here. Read the titles of some rather specialized articles and have the students indicate the branches of engineering to which they belong and name journals in which they might logically appear. Have students define any terms not generally understood. Probably every one will understand "cantilever," but the electrical student may have to define "catenary" for his classmate in the civil course. Probably a number of students will be doubtful about "telpher" and a larger number about "sonims." An occasional "skimming" of one of these current indexes should stimulate knowledge of engineering terminology among students—and it may not be bad for the instructor—but the real benefit, of course, will be in giving the student some familiarity with the scope and nature of the indexes; for any course designed to acquaint students with technical literature should be somewhat less concerned with the technical information acquired than with the sources *through which* it is acquired.

While a really instructive course should be so designed that the work will be based largely on indexes, abstracts, and bibliographies, constant use of these may result in monotony. Much will depend on the personality and resourcefulness of the instructor and on his knowledge of the subject, but there is an infinite variety of problems which may be presented. Regarding books, questions such as the following may be asked:

In what essentials do reference books differ from textbooks? Can you *compare* (not merely name) three important reference hand-books of civil engineering in use in the United States to-day? We have no recent textbooks of "civil engineering"—why? In some cases the use of a British book is permissible; in other cases very objectionable—have you any idea of the reasons which govern this? Can you name one American publisher whom you can confidently recommend for (1) textbooks on chemistry, (2) reference books and textbooks on electrical or mechanical engineering, (3) manuals of machine-shop practice, (4) practical manuals on operation of prime movers and accessories? If a new book is handed to you can you tell promptly, (1) whether it is American or British, (2) whether it has appeared in previous editions, and, if so, whether the present edition is probably very different from the preceding? (3) How would you proceed to get a prompt idea of the scope of the book? (4) What is the chief purpose of the index and does it fully serve this purpose? (5) What sources can you suggest in an attempt to find out something about the author? (6) Are the illustrations in the book apparently the best kind for their purpose? (7) If you wanted similar illustrations for an advertising booklet, or for a technical paper which you were offering to a technical journal or presenting before an engineering society, what kind of copy would you have to furnish? Can you suggest some subjects on which illustrations should preferably be in line drawing, and others to which photographic reproductions would be better adapted?

The instructor can supply an unlimited number of questions similar to (or better than) the above, and yet confine his "object lesson" to the general principles which should be observed in any consideration of technical literature. Later on, when the young engineer finds it necessary to consult or purchase engineering books, he will find that some grasp of the rudiments of book evaluation will ably supplement his knowledge of the subject matter of the books.

The few questions above are concerned solely with books, but the practice should be extended to periodical and other literature. The questions will require a little thought and investigation on the part of the student and will necessitate the use of indexes, thus affording some desirable familiarity with these. In this practice work, it should be borne in mind that the student will profit mainly by attention to the *method* rather than the *result*. It is less important that he should assimilate the literature available on a problem to-day than that he should acquire a working knowledge of how best to approach that and other literature in future.

The *minimum requirements* for the student who expects to do effective research work in technical literature may be briefly summarized as follows:

Books.—An acquaintance with the forms and use of the several types of card catalogues found in public and institutional libraries (thus enabling him to get in touch with all *books in the particular library to which he has access*); supplemented by an acquaintance with such tools as the book publishers' trade lists used by libraries and book dealers (thus enabling him to get in touch with *all books published on any subject*); and supplemented further by some knowledge of the existence and use of book reviews and other aids in book selection (thus assisting him in *evaluation of books to which he may not have access*).

Periodical Literature.—An acquaintance with the scope and functions of indexes and abstracts concerned with current technical literature and an actual working knowledge of the more important of these (thus enabling him to get in touch with *recent material not yet incorporated in books,* as well as an enormous amount of older material); supplemented by an acquaintance with the few existing guides showing *what periodicals are published on any subject and where they are published.*

Bibliographies.—A recognition of the value of bibliographies and some knowledge of how to find them (since in many cases

he will find that an existing bibliography covers all, or a large part, of his preliminary search by *assembling references to the scattered literature in books and magazines*).

A student may appear to be making great progress with the literature which the instructor or the librarian selects for him; just as an untrained manual-arts student may get credit for constructing a fine piece of cabinet work, when in reality his instructor may have done much of the responsible work. Either of these students is likely to be less well equipped for future work than the student who has stuck to rudimentary operations and practised diligently. Regarding the effectiveness of continuously repeated effort, it is well to bear in mind the Englishman's statement—"It isn't the 'eavy 'aulin' as 'urts the 'orses' 'oofs; it's the 'ammer, 'ammer, 'ammer on the 'ard 'ighway."

WHAT IS WRONG WITH ENGINEERING GRADUATES?

BY H. E. DYCHE,

Chairman, Committee on Electrical Engineering, S. P. E. E. Professor and Head, Department of Electrical Engineering, University of Pittsburgh.

NOTE: The Committee is giving consideration to this subject and would be glad to receive comments or suggestions from engineering teachers.

Teachers of engineering students often hear this remark or its equivalent, and listen patiently to well-meant criticism from prominent engineers, and strive earnestly to do this, that and the other thing as suggested. The feeling is growing of late, that many of these suggestions are contradictory in nature and cannot logically be followed.

It would seem that it is now time for engineering teachers to give some serious thought to the many published criticisms of engineering graduates. As the situation is summarized, the difficulties must concern one or all of the following parties:

(*a*) The Student,
(*b*) The Teacher,
(*c*) The Employer.

So far it would appear, the question has been largely raised and answered by (*c*), the employer. At first thought this seems to be perfectly right and proper; for who should be in a better position to judge the qualities of an engineering graduate, than the employer. As a result constructive criticism and suggestions must and will continue to come from the employer. But such contradictory and non-constructive criticism, as contained in the opinions of prominent engi-

neers published recently,* can produce nothing but harmful results.

What has the teacher or student to say in answer to this question? Judging from the silence on their part, members of the engineering teaching profession stand convicted by the impartial observer.

The manufacturer of machinery places his product in the hands of the consumer with very clear-cut directions and guarantees for it satisfactory operation. Criticism and suggested changes are being constantly received by the manufacturer, concerning design, structural details, workmanship, etc. Some are good and are adopted (in time), and many are valueless.

The engineering graduate is the manufactured product and output of the engineering and technical schools. He is not perfect. It is believed, however, that engineering teachers can suggest to the employer of engineering graduates how to make better and more effective use of their (the teachers) product; thereby changing the question to—

What is Wrong with the Employer of Engineering Graduates?

The engineers to whose opinions reference has been made, are among the most prominent in the world. They were just ordinary engineering graduates at one time tackling their first job. It is easily supposed that the big boss criticized their teachers for letting them loose, and yet these very same men will all admit they have been successful. The busy employer fails to appreciate the position of the graduate; he fails to hark back in his own mind to a similar period in his life. He expects the student to show the same progress in months that it took him years to develop; he has lost his perspective of development. Many have had this experience in dealing with students; it is quite difficult at times to bring our imaginations back to the student level, in order to appreciate their point of view. Most teachers have this trait highly developed in order to be able to appreciate the stu-

* "The College Trained Engineer," by C. Edward Magnusson, Chairman, Educational Committee, A. I. E. E., *Journal A. I. E. E.*, September, 1921, pp. 730–736.

dent's point of view; it is equally necessary that the successful employer be able to do the same thing.

Try this experiment in a highly specialized engineering organization: An expert, a well-paid engineer who has spent fifteen or twenty years in the study and application of insulating materials to transformer construction, is suddenly transferred to equipment projects in railway work. It will take this trained engineer almost as long to find himself and become productive in the new position as it will the average engineering graduate. This will be especially true if the latter be given approximately the same salary and degree of responsibility. It would seem, therefore, if engineering graduates are lacking in fundamentals, training, etc., it would be necessary in large engineering organizations to transfer highly trained men—but it is not the general practice. After all it must be easier and cheaper to train the new men.

Two other factors, which go hand in hand, and result in the dissatisfaction of engineering graduates are:

1. Over-training,
2. Lack of responsibility.

The average college graduate is mentally fatigued upon leaving school and is in no humor to continue scholastic work in the special training courses operated by many concerns. The man wants a job—not filing blue prints or chasing orders—but a real job under some wide-awake engineer, who is not afraid of his job. Some older engineers feel that if they open up the secrets of their special assignment they will be replaced by the new and less experienced graduate; and this often happens. It must be a job which carries with it responsibility. You can not fool him. He learns very quickly to appreciate this degree of responsibility. The greater it is, the greater effort he will put forth, and very shortly will definitely succeed or as definitely fail; which, after all, is what the employer wants to know as quickly as possible.

This was the experience of the engineering graduate twenty-five or thirty years ago. His technical training was not critically surveyed. His grounding in fundamentals was not made the basis of psychological tests. He was given a real job, real pay, real responsibility and success or failure followed within a very short time.

Educational-Industrial Coöperation Needed.

A closer coöperation on the part of practicing engineers and engineering teachers will be required to clarify much of the discussion now being carried on. The continued silence on the part of engineering teachers and non-constructive criticism by engineers can never bring about that mutual understanding so necessary for the success of engineering teaching.

The four founder engineering societies can do more than they have in the past toward bringing about this understanding. They all have educational committees but almost no attempt is being made to coördinate their activities with similar committees in the S. P. E. E. A notable exception was the recent joint meeting between the A. S. M. E.† and S. P. E. E. in New York City. This movement is undoubtedly a step forward in the solution of this important engineering problem.

† Joint Session A. S. M. E. and S. P. E. E., *Mechanical Engineering*, January, 1922, pp. 1–7.

UNPREPARED FRESHMEN.

BY FRED E. AYER, *Dean*,

College of Engineering and Commerce, Municipal University of Akron.

If three quarters of a bushel of wheat cost one dollar, how much will one bushel cost? Seventy per cent. of an economics class gave a wrong answer.

The sine of an angle is 2.416 divided by 24.16. Find the other trigonometric functions. Three quarters of the class were unable to perform the division correctly and the answers ranged from one, a whole number, to .0001.

Every college instructor can furnish his own quota of illustrations showing inability to add, to spell, to write legibly, etc. But what can be done about it? The colleges are prone to disclaim responsibility and reply, "Ask the high schools." But are not the colleges responsible for nearly everything in a college preparatory course? The quantity requirement of fourteen to sixteen credits fixes the length of the course. The "required subjects" determine a large proportion of the curriculum; and such phrases as, "algebra through quadratics," specify the amount of ground to be covered in many of the subjects. It must also be remembered that the high school of today is *not* primarily concerned with preparing students for college, nor should it be. The secondary schools have their own problems, and they must wrestle with them. Our question is: What can the colleges do to better the preparation of their students?

The abolishment of entrance examinations has undoubtedly lowered the standard of preparation. The boy who finishes his algebra in the middle of his second year in high school comes to college two and a half years later, remembering very little of it. If he were required to pass an entrance examination, he would be forced to review this prepar-

atory work. Entrance examinations need not be required in all subjects, but only in those which are considered as prerequisites. Therefore, certificates could still be accepted for those credits on the elective list, and the quantity requirement could remain as it is now. Variations of this plan are in use in a number of eastern universities.

In a college whose operating cost is $250 per student per year, 40 students eliminated in the first half-year represents an expenditure of $5,000. Severe criticism is the least that could befall the officials of a factory who rejected twenty to fifty per cent. of their raw material after spending on it one eighth of the labor cost necessary for completion. It is my opinion that this elimination can be made more cheaply in a four-weeks' preliminary term. Taking for convenient illustration an entering class of 100 students, these can be instructed in four sections, and a student load of sixteen hours per week can be taught by five instructors, since the curriculum should be limited to few subjects. The cost of teaching would be $1,250 if instructors rated at $2,500 per year of ten months were used. Allowing very liberally for overhead, the cost of the elimination term would be less than half as much as under the present method.

The curriculum of the elimination term should include such basic subjects as English composition, mathematics (including arithmetic), science, etc.; and the work should be a brief review of the ground covered in high school. Intelligence tests should be made, and their results given proper weight in the eliminations.

There would also be advantages other than financial ones. Specifying in advance that only 60 were to be admitted, 125 or 150 might be accepted in the elimination term. Thus allowance for a selection from a large group would be made. Out of the 40 who ordinarily succumb during the first semester, 25 or 30 could be weeded out during the elimination term. This elimination would save not only the cost of instruction of one section throughout the first semester, but also

would prevent the lowering of morale due to the presence in classes of a large percentage of poor students. By devoting the preliminary four weeks, which might coincide with or precede the opening of college, to a review of prerequisite subjects, the students accepted would enter their college classes with their fundamental requirements fresh in mind.

Regardless of what we do to gain better preparation, we must not forget that the responsibility is all ours when we graduate the student. When we award a diploma, we shoulder all the blame for the student's scholastic deficiencies be they in machine design or in spelling and arithmetic. Therefore, although we blame some one else for the kind of students we admit, we must blame ourselves for the kind of students we keep.

THE BULLETIN BOARD—AN ADJUNCT TO TEACHING.

BY LEONARD ALLISON DOGGETT,

Professor of Electrical Engineering, U. S. Naval Academy.

In addition to the many stereotyped processes of teaching engineering, each school or each instructor generally emphasizes some unusual device for achieving results. These results may take the form of driving home fundamental principles, arousing interest, or creating a substratum of engineering knowledge. In what follows a few points are given on one such device, namely the broadening of the use of the ordinary engineering department *Bulletin Board*. The specific example chosen is that of the Electrical Engineering Bulletin Board of the Post Graduate Department of the U. S. Naval Academy. Too often, nearly always in the ordinary engineering school, the bulletin board is devoted exclusively to lesson and laboratory assignments, rules and regulations, lost and found, in short to routine matter about as inspiring as a railway time table. Necessary as such uses are, why stop with these?

The following plan is in use in the Electrical Engineering Section at the writer's school. As each subject is taken up in class or laboratory, a group of pertinent illustrations is displayed on the bulletin board. Such illustrations consist mainly of clippings from the technical journals—advertising section as well as articles. To a smaller extent they comprise material drawn from trade catalogs, naval publications, blue prints, and specially prepared material not in print. The maintenance of an up-to-date stock of clippings is very essential, almost the sine qua non to the system. When reliance for illustrative purposes is placed solely on text books, the student will be left in ignorance of the developments of the

last five or ten years. Furthermore the carrying on of a live clipping and filing system is one method that the engineering teacher has of keeping himself abreast of the times.

The plan is further explained by the partially filled-in table below, taken from the author's lecture notes.

Date	Subject Treated	Post
———	Magnetic Circuit	Folder A
———		———
———		———
———	Parallel Operation of D.C. Generators	Folder D
———		———
———	Bushing Design	Folder M
———		———

Explanation of Table. Folder A shows *Magnetic Brakes* (*a*) of disc type, (*b*) of solenoid strap type, a *Magnetic Chuck*, a portable drill with a *Magnetic Holding-on Gear*, a *Magnetic Clutch*, a *Magnetically Operated Valve*, a *Magnetic Separator*, and two types of *Lifting Magnets*.

Folder D shows six Battleship Daily Load Curves, *i.e.*, D.C. amperes supplied at each hour for the U. S. S. *Texas* and for the U. S. S. *Arizona*, the former a 125-volt ship, the latter a 240-volt ship. Curves illustrate both busy and light load days, also the number of generators in use at each particular time of day.

Folder M shows external and cross-section views of number of commercial types of high-tension bushings.

The foregoing table and appended explanation should set forth the idea—which put in the form of a few maxims is, "Make your *Bulletin Board* attractive."—"Let your *Bulletin Board* help your teaching."

NOTES ON THE COMMERCIAL ENGINEERING CONFERENCE, PITTSBURGH, MAY 1 AND 2, 1922.

BY CHAS. F. SCOTT.

"Does not the program for the Pittsburgh Conference on Commercial Engineering really cover the ground which is appropriate to the S. P. E. E.?" asked one of our members a few weeks before the meeting. My answer then was "yes." After attending the meeting the answer is that substantially everything read or said would have been quite in place at an S. P. E. E. Convention.

It is worth thinking over: the United States Bureau of Education's second public conference on Commercial Engineering (which is a short way of saying supplemental commercial training for engineering students and supplemental engineering training for students in Schools of Commerce) deals with substantially the same questions in substantially the same way as our own annual Conventions. But the attendance was broader; there were deans of Schools of Commerce as well as Schools of Engineering and there were men prominent in industry. It would have been a splendid thing if our engineering teachers could have attended in much larger numbers. I wish that the two days' session might have been held in conjunction with our own annual Convention.

The published proceedings will contain much that is worth while, suggestive and inspirational reading for engineering teachers.

The following are some of the impressions written on the day following the session.

1. The high type of men from Engineering Schools and Schools of Commerce and from the industries, and the serious and constructive attitude which prevailed, indicated that all

are alive to the problem and are ready to do the reasonable thing.

2. The general sentiment as to engineering courses seems in accord with the statistics presented which shows an average of between 6 and 7 per cent. of "Commercial" subjects, *i.e.*, economics, accounting, business law, etc., in the four-year engineering courses.

3. Everybody seemed agreed and nearly everybody said that the fundamental thing in education is "fundamentals." Nobody essayed to define the term. Negatively, "fundamental" seemed to mean not specialized. Furthermore, there appeared to be several orders or degrees of fundamentals. Thus a *"fundamental"* engineering course is one which deals with basic things and not their special and possibly ephemeral applications. Again, one of the *"fundamentals"* of an engineering course is physics. Again, Dr. Mann urged that a physics textbook of 600 or 700 pages presents as many or more specific things without segregating and emphasizing the two dozen *"fundamentals."* But the significant thing was the emphasis on fundamental rather than specific training by the big men of industry, notably Dr. F. B. Jewett, Vice-President of the Western Electric Company and Mr. E. M. Herr, President of the Westinghouse Electric and Manufacturing Company.

4. There was general accord that the business of the schools is primarily to make *good beginners,* men who are prepared to conduct their own self-education in their graduate years in industry. Training in the industries is the function of the industries themselves and not of the undergraduate schools. The larger industries provide training courses. Night schools, extension courses or correspondence courses serve others. Some students who drift through college spending four happy years at the cost of just enough effort to get by the passing mark, wake up afterwards and become very studious in order to make up for lost time.

5. The joint responsibility of the school and the industry

for producing engineering and industrial leaders was assumed. Some of the men of industry said that the responsibility lay more largely with industry than with the schools as industry has not analyzed and presented the requirements as to the number and type and qualities of men which are needed. It has not supplied the specifications which the schools should meet. Conferences, coöperation and coördination are needed.

6. The personal qualities of the graduate were strongly emphasized. Not knowledge, but training; not what a man has done, but what he can do; not his mental and technical qualities but the personality and character which are essential to large progress and to leadership were the qualities sought. Selection of students at the beginning of their college courses; vocational guidance; information as to the fields of activity and the qualities essential to success in them were stressed.

7. The personal relation between teacher and student; influence of the teacher aside from what he teaches; the ideals, the outlook, the inspiration which the teacher imparts to the student, are the great factors in education. The business of the teacher is not to teach subjects but to teach boys.

8. The men from the industries were men of wide experience. C. R. Dooley said that he had interviewed probably 8,000 students and visited all the institutions east of the Rocky Mountains. S. L. Nicholson had experience with 700 or 800 college men in sales work. S. E. Doane had experience with a great variety of men in the lighting industry. He remarked that he thought they got the best men from the engineering courses because these were the most unpopular courses. They had the reputation of being the hardest. The men who took them were often partially self-supporting. These are the conditions which bring forth the best men. When engineering courses become popular their product may deteriorate.

The foregoing impressions and observations do not present,

by any means, a complete statement of what went on. This is not a report of the meeting; it is simply a comment.

The emphasis on fundamental teaching, upon the relations of professor and student, the value of conferences between engineering teachers and other teachers of engineering students and the broader outlook which comes from conferences with the users of engineering graduates all emphasize the value of the Branch organizations of the S. P. E. E. in each institution.

SECTIONS AND BRANCHES

The Case School of Applied Science, Branch of the S. P. E. E., was formally organized on March 15. Professor W. R. Veazey was chosen to act as chairman of the meetings for the coming year.

At the same meeting the following papers were read: "The Advantages and Disadvantages of the Lecture System" by Professor Veazey of the Chemistry department, and "Methods of Laboratory Instruction" by Asst. Professor Stark of the Mechanical Engineering department. Both papers were followed by open discussion.

The Ohio State University.—For several years the Seminar Committee of the College of Engineering has given a program of lectures by members of the instructional force, followed by discussion. This year the program consists of a series of lectures by Professor Boyd H. Bode, head of the Department of the Principles of Education. The first one was delivered on October 28, 1921, on "Teaching Students to Think," to about 150 persons, and was followed by a general discussion in which a dozen or more took part.

His second lecture was on "The Purpose of Education" and was given on March 10. His later lectures will be on "The Cultural and the Practical" and "How the Mind Works." Professor Bode's lectures will alternate with those by other members of the faculty. The one on March 24 was by Prof. C. W. Foulk on "A New and as yet Untried Plan for Teaching Students How to Study."

On February 24 the local members of the Society decided to form an Ohio State University Section of the Society. At a recent Engineering Faculty meeting the members of the faculty decided that they would unite with the Columbus members of the Society to form the Ohio State University

Section of the S. P. E. E. and to make the Seminar Committee the Executive Committee of the Section.

Dean E. A. Hitchcock has appointed Professors Magruder, Coddington, and Withrow a committee of the faculty to have charge of the meeting of the Ohio members of the Society at Columbus on April 15.

Providence Meeting of the New England Section of S. P. E. E.

The spring meeting of the New England Section of the Society for the Promotion of Engineering Education was held at Brown University, Saturday, March 25.

The first session was called to order in the Engineering Building at 11 A.M., by Dean Anthony. The records of the Orono meeting were read and approved.

The following committee on nomination of officers for the ensuing year was appointed: Messrs. Franklin, Williston, and Hall.

After a discussion it was voted that the fall meeting should be at the University of Vermont.

Professor Franklin reported for the Nomination Committee as follows: "It is the opinion of the committee that the present officers should be returned to office for the ensuing year." The motion was duly seconded and carried, and the following officers declared elected: Chairman, Dean Gardner C. Anthony; Secretary, Dean Harold S. Boardman.

The question of whether one or two meetings of the Section should be held during the year was discussed. No action was taken, but the general sentiment appeared to be that a central meeting should be held within about fifty miles of Boston in the spring, and the other, or fall meeting, should be at one of the more remote institutions.

At 12:30 a very appetizing lunch was served by the University, and at 2 P.M. the second session was held in Wilson Hall. Dean Anthony introduced President Faunce, who wel-

comed the Section to Brown University in a very pleasing manner.

The afternoon session was devoted to the discussion of various topics, and was in the nature of a round-table discussion without prepared papers. The following questionaire had been previously distributed:

1. What can be done to increase intellectual earnestness and to decrease the casualness and "don't care" spirit?
2. To what extent should the teacher of engineering subjects supplement the work of the English department?
3. What degree of coördination with allied subjects do you maintain?
4. To what extent is class visitation observed in your institution?
5. Do you employ any systematic method for studying the characteristics of your students, their methods of study and general development, irrespective of their knowledge of the subject taught?
6. What is done toward assisting, advising, criticizing, or in any manner encouraging better teaching by the members of your faculty?
7. What is the object of a recitation and what should be its character?
8. (*a*) To what extent is it desirable to employ our own recent graduates as assistant instructors?
   (*b*) To what extent is it desirable for a college faculty to be made up of its own alumni?
9. What supervision is given to the preparation and marking of examination papers?
10. How may a young teacher obtain prestige with his students?

No attempt was made to report the remarks of those present, but the discussions were very lively and to the point. In addition to the above topic, remarks were made upon the following:

(*a*) Methods of teaching English and the kinds of English taught.

(*b*) The kind of questions asked in examination.

(*c*) The development of the thinking powers in students vs. passing out information upon a silver platter.

(*d*) The division of a class into three groups, according to scholarship.

(*e*) General examinations at end of second and fourth years to test the student upon knowledge. These examinations to be given in addition to those regularly given.

(*f*) To what extent should we educate the so-called "boneheads?"

Meeting adjourned at 5 P.M. to the Carter Brown Library where a very pleasant hour was passed in examining the exhibits, and in social intercourse.

Dinner was served at 6:30 at the Crown Hotel, after which the Chairman introduced Dean Randall, who gave a very pleasant talk upon the human side of relations between teacher and student.

President Scott was present and in his talk suggested the idea of forming a new control of the Society by placing at its head a man under salary who could devote his time and energy to the affairs of the Association.

After many remarks and a very pleasant and profitable evening, Dean Hughes proposed a rising vote of thanks to the President and Faculty of Brown University for the many courtesies which were shown. A resolution was also adopted thanking the officers and Program Committee for their activities in making the meeting a success.

The attendance was sixty, of which forty were members.

The meeting adjourned at 9:30 P.M.

Columbus Meeting of Ohio Members of S. P. E. E.

The success of the meeting of Ohio members of S. P. E. E. at Columbus, April 15, called at the suggestion of President

C. S. Howe, Case School of Applied Science, would seem to demonstrate convincingly that section meetings fill a need, and offer fresh inspiration to all who attend. The program left a definite impression.

At the morning session, which was, in part, a joint meeting with the Ohio Section of the Mathematical Association of America, mathematics and English were the topics considered. The mathematics discussion was based upon the papers presented by Philip C. Nash, Dean of Antioch College; by K. D. Swartzel, Professor of Mathematics, The Ohio State University; and by E. F. Coddington, Professor of Mechanics, The Ohio State University. Dean Nash outlined the fundamental aim of Antioch College—to train students to be proprietors rather than subordinates in large corporations. He defined the proprietor as one who cannot get help farther up. That is, the one who has the final decision and who bears the responsibility. To educate the student for this work, the course of study at Antioch is divided about equally, during the six years, between practical work and study in the class room. The studies here are in turn divided into those which have to do with the technique of proprietorship and the particular vocation which the student has selected, and those which will give the student knowledge in all the great fields of human endeavor.

Professor Swartzel, in "Segregation in Mathematics Classes, an Experiment in Freshman Mathematics," presented the results of a comparison of grades of students in segregated and in non-segregated sections. His figures seemed to indicate that students in segregated sections make higher grades than those in non-segregated ones. Dean E. A. Hitchcock, College of Engineering, The Ohio State University, reported, in this connection, that fewer freshmen than sophomore engineering students had been called in the middle of the second semester on account of poor scholarship, and called attention to the probable relationship between segregation and scholarship. In "First Lessons in Calculus to Engineering Students,"

Professor Coddington noted the fact that the ordinary text-book on calculus makes no attempt to define a derivative in terms of physical concepts, and gave concrete examples of how, by using these physical concepts in the definition, he simplified the teaching of calculus with excellent results.

The feeling of those particularly interested in mathematics seemed to be that perhaps standards for college entrance in mathematics might be tightened, and that some method of rating students after they have entered college would raise scholarship.

(1) Should technical reports be graded by an instructor in English? and (2) What can be done to improve the work in English (*a*) by the instructor? (*b*) by the student? were the basis of a topical discussion led by Miss Sada A. Harbarger, instructor in English, The Ohio State University. According to Miss Harbarger, "While the student has some responsibility in the way he meets the requirements which all his technical and English courses impose, the great responsibility rests upon his instructors. In fact, the English of the engineering student can be permanently improved only by the coöperation of the technical and the English instructor, the former supplying the stimulus, the latter tying these professional enthusiasms with life and the broad aims common to men in every profession." Through a letter, read by Professor Magruder, Professor J. R. Nelson, chairman, Committee No. 12, stated that coöperation between the English and the technical departments is desirable, the technical department giving the grade; the English department serving always in an advisory capacity. He described briefly, also, the method of handling of reports by the English department of the University of Michigan. President Scott pointed out that only by means of English can an engineer pull himself out of a routine job, and Secretary Bishop commented upon the fact, usually overlooked, that the engineering student puts his English to a greater variety of uses than the student in the liberal arts college. Others presented their methods of

emphasizing to the technical student the need for clearness of presentation.

At the afternoon session, methods of teaching and of rating were considered. "Specifications of a Teacher of Engineering," given elsewhere in this issue of the BULLETIN, were presented by Frank H. Neff, professor of civil engineering, Case School of Applied Science. "Advantages and Disadvantages of the Lecture System," by William R. Veazey, associate professor of chemistry, Case School, suggested in a very interesting and animated fashion, the advantages of the lecture method of conducting classes if the material has been well planned by the lecturer, and clearly and accurately given the students. The textbook method, Professor Veazey thinks, often does not give the student sufficient training so that he can act for himself when he is confronted with a practical problem. When erroneous statements slip into textbooks, the weakness of this method of securing knowledge is increased.

Theodore M. Focke, Dean, Case School, reported upon the results of applying the army, the Thurstone and the S. P. E. E. tests to students in Case. The curves, plotted by Dean Focke, upon these tests were practically identical, and led him to conclude that there is a direct relation between intelligence tests and scholarship in the aggregate. Professor L. L. Thurstone, department of psychology, Carnegie Institute of Technology, gave briefly and clearly some explanations of just what might be expected from psychological tests at the present time, and what has been the significance of those thus far attempted. He seemed to feel that thus far the tests should not be taken as final evidence, but as suggesting possibilities for rating and guiding. The ideas of Boyd H. Bode, professor of principles of education, The Ohio State University on "Liberal and Professional Education" are presented in the BULLETIN in full. According to James R. Withrow, professor of industrial chemistry, Ohio State University, the most successful "Organization of Research Courses" is effected when the graduate students are required to report in detail from week

to week the progress that they have made in their particular research problem. This method, Professor Withrow feels, trains students to carry a problem through to the end.

At the business meeting of Ohio members, it was voted to form an Ohio Section of S. P. E. E., and Professor W. T. Magruder, professor of mechanical engineering, The Ohio State University, was made acting chairman.

WRITTEN DISCUSSION.

BY J. RALEIGH NELSON,

University of Michigan.

One of the questions you asked in your letter had to do with a subject which is just now interesting us very much in my own department at Michigan. You ask what seems to be the best plan for securing for the student in engineering some systematic criticism on the side of his English composition. Ideally, I should say that every paper written by a student, whether it be a formal exposition, a quiz paper or a laboratory report, should be criticized with reference to its clarity of form and its correctness as to the details of English composition. Ideally, too, I should say that all such criticism should be given by the instructor who was examining the paper for the accuracy of its statements and the value of its content. Practically, I am sure that any one familiar with the conditions under which our instructors work, will realize that such criticism is not likely to be given and that, both because of the limited time and the limited capacity for such criticism, most instructors in technical engineering subjects can not undertake it except in the most general way. While, therefore, the coöperative effort of two critics, one on the side of content, and one on the side of form, is wholly illogical and quite to be regretted, it is often the only hope for anything like a constructive program in training our students to accurate and effective composition.

At Michigan, we are moving definitely in two directions; first, we are definitely trying to get all instructors who read any student papers of any sort, to note mistakes in spelling, punctuation, grammar and glaringly bad sentence structure; then, we are trying to work out by experimentation some co-

operative plan which shall associate an English instructor as critic or helper with the junior and senior courses where formal papers are required. In attempting this experiment, I have had one or two very definite conditions in mind as prerequisite for its success. I have insisted:

1. That this shall not degenerate into a plan for having the members of the English staff "read papers" for the instructor in engineering, with a view to relieving them of their natural and inevitable responsibilities.
2. That the English instructor shall meet the students for whom he is to serve as critic and guide both as a group and as individuals.
3. That as largely as possible he be regarded rather as an advisor than as a critic.

Accordingly each English instructor has, at the beginning of the semester, been assigned to a class in some technical subject. He meets this class as a class, talks to them on some of the fundamental things he wishes them to keep in mind, and plans with them for the semester's work. Then each man in the class has a definite appointment with the English instructor, when he can confer with him in his office regarding the papers he is to prepare. It is required that every paper be prepared from a plan submitted to and checked by the English instructor, and the rough draft is, in some cases, gone over before the final copy is made. When the paper is finished, it is submitted, first to the English instructor for criticism, after which it goes to the engineering instructor and is then rewritten or revised for both form and content for final checking.

We have been inclined to think it better for the English instructor *not* to give a *grade*. By throwing the entire emphasis on his function as helper and guide and by giving him, especially, an opportunity for work on the preliminary planning and shaping of the papers, we have escaped the resentment which we feared if our criticism virtually lowered the

standing of students who were strong on content but weak on form.

So far, both instructors and students seem enthusiastic over the plan. It has demanded careful routing of the papers and a very definite program of operations before the semester's work began, but this has been no actual hardship to any one.

My own feeling is still very strongly against either students or members of the technical staff getting the impression that we are merely "reading the papers" or that we are snooping about where we have no business in an effort to make them appear ridiculous. I want the relation between my men and their students a very personal one, and I want the students to get the feeling that we are simply disinterestedly helping them to understand what they are about, to go about it intelligently, to get a plan or design for their piece of work that will stand criticism as a design, and to construct their composition consistently on that plan.

In the case of laboratory reports, our procedure is, of course, somewhat different. There is less need for preliminary planning and the conference work is correspondingly less. The English instructor and the technical instructor agree at the beginning of the semester on the form for such reports. Then the English instructor meets the class, gives them a talk regarding the form and composition of their reports, and gives a style sheet according to which he will make his criticisms. He has his regular conference hours, at which any student may see him, and three times each semester is required to see him. On these occasions, the instructor goes over the typical difficulties which he has found in the student's work and tries to direct him toward the elimination of these difficulties. Here, as in the case of more formal papers, the stress is wholly upon the improvement in the work rather than on the grade.

The other two questions you ask in your letter are so large that I must beg you to excuse me from discussing them this

time at any length. Our experience at Michigan leads us to feel that the very best way to arouse a fine professional spirit among the men teaching engineering students, is to give them their own staff which is identified with the engineering faculty and which is encouraged to study its own special problems in a special way. Given an enthusiastic group of English instructors and a general and consistent appreciation throughout the engineering faculty of the value of English training, and the problem of interesting the students is already half solved.

COLLEGE NOTES.

University of Illinois.—Advanced courses in mechanics and mechanical engineering will be offered in the coming summer session of the University of Illinois beginning June 19, 1922. It is thought that these courses may prove attractive to some of the younger members of the instructional staffs of engineering colleges of the country and to others who wish to spend further time in study.

The offerings this summer are in mechanics and mechanical engineering.

OBITUARY.

Mr. J. Fay Wilson was born in Bellflower, Illinois, his family soon after removing to Kansas. He received his elementary education in the public schools of Kansas; attended the University of Kansas and was graduated in 1909 from the engineering course with the degree of Bachelor of Science. From 1905 to 1908 he was manager of utilities at Anthony, Kansas and Woodward, Oklahoma. During 1909–10 he designed and built a central heating plant for Southwestern College, Winfield, Kansas. From 1910 to 1911 he was with the U. S. Steel Corporation at Joliet, Illinois, engaged mainly in power-plant design. From 1911 to 1916 he was on the instructional staff of the College of Engineering at the University of Michigan; during 1916–17 professor of electrical engineering at Queen's University, Kingston, Ontario; from 1917 until the time of his death, February 15, 1922, he was professor of electrical and mechanical engineering at the University of Southern California, Los Angeles.

Professor Wilson is the author of two texts which have been used quite extensively; one is "Essentials of Electrical Engineering," which, as its name implies, is a text for beginning classes in colleges and technical schools. The other was a "Manual of Laboratory Practise."

Professor Wilson was a member of this Society since 1913.

BOOK REVIEW.

The Elements of Specification Writing. RICHARD SHELTON KIRBY, C.E. Assistant professor in the Sheffield Scientific School of Yale University. 153 pages. John Wiley & Sons., Inc. Second Edition Revised.

A textbook in the underlying principles of specification writing and not merely a group of specifications although the principles are abundantly illustrated by sample specifications. Takes up the essentials of a contract, the advertisement, and information for bidders, and the essentials of a proposal, together with the various general and specific clauses constituting the specification proper. An appendix gives a large list of readily accessible references, to current periodicals affording a large mass of illustratory material. Outlines for technical clauses covering nine simple construction projects will assist the student in the preparation of actual specification. These outlines cover such projects as a sewer, a macadam road, a highway bridge, an earth dam, a frame cottage, etc., all being projects with which the student is more or less familiar.

L. W. M.

THE MATHEMATICAL ASSOCIATION OF AMERICA.

The **National Committee on Mathematical Requirements** regrets to announce that, owing to unfortunate delays in printing, its complete final report, "The Reorganization of Mathematics in Secondary Education," *will not be ready for distribution before May,* 1922. Requests for free copies of this 500-page report may be sent to J. W. Young, chairman, Hanover, New Hampshire. Owing to the labor and expense involved, *the receipt of applications for copies of the report is not, in general, being individually acknowledged.* Applicants may rest assured, however, that their requests will be filled when the report is ready for distribution.